WASHINGTON STATE DEPARTMENT OF Natural Resources | Sustainable Recreation Work Group
CONNECTING YOU AND THE OUTDOORS

Environmental Impacts Paper

I) Introduction

Every year, over 11 million people recreate on lands managed by the Department of Natural Resources (DNR). Several studies have shown that outdoor recreation, "because it occurs in natural environments, inevitably causes some degradation… even under light to moderate levels of use…" (Hammitt and Cole, 1987). Impact, in this environmental paper for the Sustainable Recreation Work Group, is defined as "any undesirable visitor-related biophysical change of the [natural] resource." (Leung and Marion, 2000). Human activity in nature that may appear benign can still cause significant harm to the environment if not managed properly. By summarizing existing studies, this paper will discuss the various environmental impacts caused as a result of outdoor recreation. In addition, the paper will also offer recommendations for ways to lessen the impacts of recreation through proper planning, design, construction, maintenance, and enforcement.

Illegal activities on DNR-managed lands

Most members of the public who visit DNR-managed lands do so to recreate. However, there are a few individuals whose activities on DNR-managed lands, ranging from garbage dumping to building drug labs, are illegal and have a detrimental impact on the environment. In 2008, DNR removed over 106 tons of garbage from DNR-managed lands. Drug labs, which are occasionally discovered on DNR-managed lands, pose serious environmental and human health risks, as substances found at many of them can be lethal if inhaled or touched. (Hunter, 2000).

Designated vs. undesignated recreation

Recreational activities that occur on DNR-managed lands are defined as either designated or undesignated. For DNR-managed lands, "designated' means any facility, trail, or location that has been approved by the department [DNR] for public use." (WAC 332-52-010). Designated recreation on DNR-managed lands includes the 143 campgrounds, trailheads and day use areas, as well as the over 1,000 miles of trail which are managed by DNR. Undesignated trails, and some facilities, are built by members of the public who have not received DNR approval, nor funding from the legislature to properly design, construct, and maintain them, nor to provide an adequate level of education and enforcement. Undesignated trails are more prone to environmental impacts, liability and safety concerns, because they are not planned, designed, constructed and maintained properly.

Dispersed and developed recreation

Dispersed recreation is any "recreation activity performed without the benefit of facilities [or trails] designed for that activity." (Nelson, 2007). Activities such as berry picking, fishing, geocaching, and hunting are generally considered dispersed recreation. Other activities, like hiking and camping, can also occur in a dispersed fashion, even when trails and campgrounds may exist nearby. Activities generally considered dispersed are usually low impact in nature, and do not raise many environmental concerns unless there is a large amount of use.

In contrast, developed recreation is focused in a specific area that utilizes a facility and/or trail. Mountain biking, horseback riding, and ATVs are trail based activities that would qualify as developed recreation. Paragliding and hang gliding, which require a cleared launch site, and car camping, which requires campsites, are also examples of developed recreation. Throughout DNR-managed landscapes, there are activities that would normally be considered developed recreation uses occurring in a dispersed fashion. Given the nature of developed recreation uses, they usually cannot occur in an environmentally sustainable manner on a landscape without well-designed, constructed, and maintained facilities and trails. When developed recreation uses do occur in a dispersed fashion (*i.e.*, away from designated trails), there are usually significant environmental issues.

II) Environmental Impacts by Resource

Soils

The impact to soils from recreation can be substantial. Currently, DNR manages over 1,000 miles of designated trails, and it is estimated that there is more than two and half times that number of undesignated trails. (DNR, 2007; RCO, 2008). One study done by the National Park Service found that undesignated trails in general were over three times more eroded than designated trails. (Marion, 2006). Assuming erosion rates based on that National Park Service study, soil loss to erosion from designated and undesignated trails on DNR-managed lands could potentially equate to over 484,000 cubic yards annually, which is almost three times the volume of the Washington State Capitol Building. (Marions, 2006; GA, 2008).

Erosion of trail surfaces caused by trail use is not an impact that the environment can recover from over time unless the trail is removed, since it is the trail itself that causes most of the environmental impact. (Jewell and Hammitt, 2000). Displacement of soils can also occur as a result of trail use, particularly when soils are saturated or loose, resulting in ruts or grooves along a trail. (Meyer, 2002). Several studies have shown that environmental factors such as slope gradient and type of soils are more important in determining ground incision and soil erosion than use-related factors (e.g., the type of recreational use). (Marion and Leung, 1996). Location, rainfall intensity, and slope gradient are environmental factors that a play primary role in the amount of soil loss, while soil properties (e.g., structure, texture, and moisture content) play secondary roles. (Wilson and Seney, 1994). Saturated areas with fine soils, such as wetlands, are key examples of locations that are highly susceptible to environmental impacts from recreational use. (Schlichte, 1998). Given the importance of environmental factors, placing a trail in the proper place on a landscape is critical in reducing impacts to soils caused by recreation.

As illustrated above, a trail in the wrong location can cause severe environmental degradation through loss of top soil and impact to the natural water drainage of the ecosystem. The picture on the left shows a trail in a riparian area, and the middle and right pictures show trails that are on steep slopes.

While environmental considerations are the most prominent factors to evaluate for environmental impact on a trail, the degree of impact caused by use-related factors (*i.e.*, the type and amount of recreational use) can be substantial. (Marion, 2006; Cole, 2005). Different recreational uses will have different levels of impacts on soils. When controlling for other factors such as trail slope, soils, etc., off-road vehicles and horses cause a substantially greater degree of soil compaction and erosion than human-powered trail activities (e.g., mountain biking and hiking). (Marion, 2006; Wilson and Seney, 1994; Deluca, 1998). However, it is important to note that all uses have the potential to create a substantial environmental impact if a trail is poorly placed, designed or maintained. (Marion, 2006; Schlichte, 1998). For instance, a mountain bike trail that is poorly positioned and maintained could result in more environmental issues than a well-positioned and maintained horse trail. (Marion, 2006).

While "the initial trail traffic is much more damaging than subsequent traffic," increased trail use still creates a greater overall impact to the environment. (Deluca, 1998). There is a strong link to high amounts of trail use and an increased need for maintenance, especially in saturated conditions. (Schlichte, 1998). Mitigation measures, such as trail hardening or creating boardwalks, can reduce environmental impacts caused by trails. (Marion, 2006; Meyer, 2002; Schlichte, 1998). However, by failing to maintain trails as a result of high amounts of use, the success of mitigation measures on the trail is lessened, thereby resulting in greater environmental impacts. (Schlichte, 1998). By maintaining trails in relation to the intensity of use it receives, the environmental benefit from a properly designed and constructed trail can continued to be realized. (Meyer, 2002, Schlichte 1998).

Camping can also have an impact on soils. The concentrated use of dispersed campsites where there is not a well-defined boundary can result in the nutrient properties of soils being affected by people continually walking in and around an area. (Zabinski, 2002). Soils near campsites can also be compacted due to continuous use resulting in increased risk of erosion and runoff. (Cole, 2000). The removal of brush and downed wood for campfires can have an impact on both wildlife habitat and soils.

Vegetation

The use of campgrounds, trails and roads by recreational users presents two potential environmental impacts to vegetation: 1) loss of vegetation and 2) the introduction of invasive species. The first type of impact, vegetation loss, varies greatly depending on the type of vegetation being impacted, and the type and amount of trail use. (Cole, 1988; Cole and Trull, 1992). The most substantial factor affecting vegetation loss is the durability of the type of vegetation, which is based on a species' resistance and resilience to being disturbed, and the ability to recover following trampling. (Cole and Trull, 1992).

At the lowest levels of recreational use, 200 to 400 passes by hikers, some species of vegetation may recover from trampling and soil compaction in short periods of time (e.g., a year); however, once recreational use meets or exceeds moderate levels the impacts to vegetation will be substantial and may take several years for recovery to occur. (Cole, 1988; Cole and Monz, 2004). The amount of weight bearing force of a user also affects the amount of vegetation loss and soil compaction. (Thurston and Reader, 2001). Compacted soils as a result of trail and campground use may not only affect the vegetation immediately being removed, but future vegetation growth may be impeded due to nutrient loss. (Cole, 2000; Zabinski, 2000).

Winter recreation can also cause vegetation loss. Unlike other trail uses, snowmobilers and cross country skiers do not directly contact soils. They do, however, compact snow. (Mieczkowski, 1995). Compacted snow can cause erosion as a result of increased runoff. It can also lower temperatures in a given area, which can harm later growth of springtime vegetation. (Mieczkowski, 1995; Joslin and Youmans, 1999).

The second concern relates to the spread of invasive species. Across the state of Washington, invasive species threaten the state's biological richness and diversity, and various industries (e.g., timber, agriculture, etc.). (WISC, 2008). Invasive species can be highly adaptable to a variety of environments, spread easily, and displace or eliminate native vegetation. Recreational trails and roads can serve as primary corridors for the transportation of invasive species that threaten the vegetation makeup of the forest. (Tyser and Worley, 1992). The tire tread from cars, off-road vehicles and mountain bikes; the undercarriages of off-road vehicles; the hulls of water crafts; the shoe soles of hikers and horses; and horse fecal matter are all means by which invasive species can spread throughout a landscape. (Lacey, 1997, Wells and Laueroth, 2007, Kimberling, 2005). While transporting invasive species often occurs passively, it takes a significant effort to remove them once these species are established in a landscape.

Water Quality and Streams

The connection between human waste from outdoor recreation (for example, as part of hiking and camping) and its ultimate effects on "aquatic systems are poorly understood and probably highly variable." (Cole, 1999). Research done so far indicates little threat to water quality from human waste as a result of outdoor recreation, with the exception of recreational facilities receiving high levels of use (from boating, fishing, and swimming) during peak seasons. (Cilimburg, 2000).

Recreational trails and roads, depending on their location and design, have the potential to deposit large amounts of sediment into fish-bearing streams. (Schlichte, 1998; Bilby, 1989; Bilby, 1985). High levels of sediment (several tons), delivered into streams can increase the mortality of salmonid eggs and alevins, reduce food sources for various aquatic species, destroy spawning grounds and degrade overall aquatic ecosystem health. (Bilby, 1985; Platts, 1989; Cole and Landres, 1995; Forman and Alexander, 1998). In an Idaho study, a single forest road deposited 1,268 tons of sediment into a river over the course of a year. (Platts, 1989). The end result of sediment delivery from recreational roads and trails into streams is harmful to fish and the aquatic ecosystem.

As shown above, runoff from roads and trails can deliver larges quantities of sediment into nearby streams.

Unmanaged recreational outdoor shooting activities (“drop-in” shooting sites) on public lands can also have an impact on water quality. With enough accumulated use, lead and other metals from bullets, shot, and gunpowder can cause toxic build up in soils. Health and environmental impacts can occur where the lead from a shooting site reaches humans and animals through surface and groundwater sources as drinking water. (DOH, 2005).

Wildlife

For many individuals, recreation in the outdoors is an opportunity to view and enjoy wildlife; however, such opportunities have the potential to affect the overall well-being of Washington’s wildlife. (WBC, 2007). Impacts to wildlife caused by recreation may be further reaching than those experienced by plants and soils, due to the fact that wildlife are able to migrate and to pass learned responses to their offspring. (Cole, 2000). Indirect impacts, like habitat modification, can affect an animal’s ability to get food, and as a result, the entire food chain of which that animal is a part can be affected. (Knight and Cole, 1995a).

A key factor in determining the degree to which wildlife are disturbed by recreational use relates to the location in which the disturbance occurs. Studies have shown that wildlife appear more disturbed by recreational users in areas where humans are less common (e.g., off-trail). (Miller, 2001; Kenny and Knight, 1992; Bowles, 1995). As a result, keeping human recreational activities focused to discrete areas can be important in reducing the degree of any disturbance.

Wildlife are more susceptible to the stress caused by a disturbance during certain periods of time such as during the winter, migration, or pregnancy. (Anderson, 1995; Joslin and Youmans, 1999). Continuous stress placed on wildlife as a result of recreation during periods of heightened susceptibility may eventually cause illness or death, including an increased potential for pregnant wildlife to abort. (Anderson, 1995).

Wildlife are also affected by habitat modification. As discussed above, outdoor recreation has an impact to vegetation, soils and streams that wildlife rely upon as part of their habitat. (Knight and Cole, 1995a). As a result, any impacts that compromise a habitat may also compromise the wildlife that relies on that habitat.

Forest fragmentation caused by recreation can also harm wildlife populations. Fragmentation of forests, most often caused by roads, divides the forest into patches that isolate wildlife populations and confine them to one side of the road. (Lehmkuhl and Ruggiero, 1991, Forman and Alexander, 1998). As a result of fragmentation, wildlife can have a greater susceptibility toward extinction. (Lehmkuhl and Ruggiero, 1991). Trails may cause fragmentation similar to roads, but specific studies examining fragmentation caused by trails are lacking. (Leung and Marion, 2000).

Air Quality

Both motorized trail use and general commuting via a motorized vehicle to a recreation area can have a direct impact on air quality. Comparatively, the amount of air pollutants such as carbon monoxide and hydrocarbons emitted by ATVs, off-road motorcycles and snowmobiles per vehicle are far greater than those of a passenger car. (EPA, 2002b).

For example, a passenger car would have to drive five hours to equal the amount of hydrocarbons emitted over the course of one hour by a four-stroke ATV. (EPA, 2002b). In 2002, non-motorized trail users in Washington, while driving on back roads to reach trailheads and campgrounds, emitted 4,508 tons of carbon monoxide and 494 tons of nitrogen dioxide. (EPA, 2006; RCO, 2003). For that same year, off-road vehicles (ATVs and motorcycles) emitted 1,820,899 tons of carbon monoxide and 199,766 tons of nitrogen dioxide. (EPA, 2006; RCO, 2003). Both nitrogen dioxide and carbon monoxide can affect overall human health and the environment. (EPA, 2008a; EPA, 2008b).

Particulate matter, which is raised into the air by vehicles disturbing soils, can have a significant effect on ecosystems and human health. (Ouren, 2007; CARB, 2003). In 2006, over 372,887 tons of particulate matter was released into the air nationally from off-road vehicles. In comparison, this is 25% greater than what was emitted by highway vehicles. (EPA, 2006). Other trail uses also cause particulate matter to be emitted; however, specific studies measuring the particulate matter emitted are lacking. The Environmental Protection Agency (EPA) began imposing regulations on air emissions for newly manufactured off-road recreational vehicles in 2002. (40 CFR 1051).

III) Regulatory Framework

Clean Air Act

The Clean Air Act (CAA) is the comprehensive federal law that regulates air emissions from stationary and mobile sources. The law authorizes the EPA to establish National Ambient Air Quality Standards to protect public health and public welfare and to regulate emissions of hazardous air pollutants. One of the goals of the CAA is to develop standards for every state.

Clean Water Act

The Clean Water Act (CWA) is the cornerstone of surface water quality protection in the United States. The statute employs a variety of regulatory and non-regulatory tools to sharply reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. These tools are employed to achieve the broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's waters so that they can support the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water.

Endangered Species Act

Congress passed the Endangered Species Preservation Act (ESA) in 1966, providing a means for listing native animal species as endangered and giving them limited protection. Through federal action and by encouraging the establishment of state programs, the ESA provides for the conservation of ecosystems upon which threatened and endangered species of fish, wildlife, and plants depend.

DNR has created a multi-species Habitat Conservation Plan (HCP) to address state trust land management issues relating to ESA compliance. A habitat conservation plan is a long-term land management plan authorized under the ESA to conserve threatened and endangered species. For DNR, it means a plan for state trust lands that allows timber harvesting and other management activities to continue while providing for species conservation.

Forest Practices

The Washington State Legislature passed the Forest Practices Act, which regulates activities such as growing and harvesting timber on all non-federal forestlands in the state, including forested state trust lands. The Forest Practices Rules (the rules) created by the Forest Practices Board (also established by the Act) give direction on how to implement the Act. The objectives of the rules are to protect public resources, focusing on water quality, salmon habitat, and other aquatic and riparian resources.

Growth Management Act

The Growth Management Act (GMA) was passed by the Washington State Legislature to address the threat that unplanned growth posed to the environment, sustainable economic development, and quality of life. The GMA requires state and local governments to manage Washington's population growth by identifying and protecting critical areas and natural resource lands, designating urban growth areas, preparing comprehensive plans and implementing them through capital investments and development regulations. This approach to growth management is unique among states.

Marine Mammal Protection Act

The Marine Mammal Protection Act was enacted in partial response to growing concerns that certain species and populations of marine mammals were in danger of extinction or depletion as a result of human activities. The Act sets forth a national policy to prevent marine mammal species and population stocks from diminishing, as a result of human activities, beyond the point at which they cease to be significant functioning elements of the ecosystems of which they are a part.

State Environmental Policy Act

The State Environmental Policy Act (SEPA) was enacted to ensure that environmental values are considered during decision-making by state and local agencies. Combining the review processes of SEPA and other laws reduces duplication and delay by combining study needs, comment periods and public notices. SEPA also allows agencies, applicants, and the public to consider all aspects of a proposal at the same time.

Water Quality Program

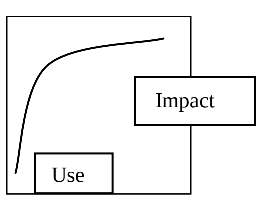
The purpose of nearly all of the work conducted by the Department of Ecology's Water Quality Program is to prevent point source pollution or reduce nonpoint source pollution, or a combination of both. Three significant methods are common to both point and nonpoint pollution: 1) controlling storm water pollution, 2) providing financial assistance, and 3) cleaning up polluted waters.

IV) Means of Addressing Impacts

Spreading use vs. Concentrating use

There is a conversation among various recreational users that by spreading recreation use occurring on DNR-managed lands, people can go more places on a landscape so environmental impacts can be better withstood. At low levels of dispersed use (for example, an area seldom traveled by hikers), spreading recreation may be able to be withstood by a landscape, if that landscape is allowed to recover over time. (Leung and Marion, 1996). This line of thinking, however, does not hold true once use, whether dispersed or developed, exceeds low levels of impacts. For instance, with developed recreation, creating several designated trails throughout the landscape, even if seldom used, is going to have a far greater impact than a few overly used designated trails. (Cole, 2004a; Jewell and Hammitt, 2000)

The impact of recreationists on the environment is a nonlinear progression in that the initial use of the land for recreational purposes will have a higher environmental impact relative to later or additional recreational use of the land. (Cole, 1993). For this reason spreading recreational use, instead of directing it to a concentrated area, will cause a greater environmental impact. (Cole, 1986). While the amount of environmental impact on a given trail may increase, the overall environmental impacts to the landscape will be much lower than by spreading use across the landscape. (Cole, 2004a).



A generalized model of the asymptotic relationship between the amount of use and the amount of impact. Where use levels are low, incremental increases in Uk amount of use have a pronounced effect on the amount of impact. Where use levels are moderate to high, incremental in the amount of use have little effect on the amount of impact (Cole, 1993)

Planning

Since every trail and campground has a different degree of environmental impact, each trail or campground will be differently suited to an area based on site specific environmental factors. One of the most important means of minimizing trail or campground impacts is undertaking proactive planning. Motorized use, for instance, has a higher impact relative to most other trail uses, and can have its impacts minimized by locating trails in areas better suited to withstand higher levels of impacts. (Slaughter, 1990). Through proper planning, trails or campgrounds can be located in an area that can better withstand impacts, while avoiding locating them in an area that is highly susceptible to environmental impacts, such as riparian areas. (Marion, 2006; Schlichte, 1998).

Design and Construction

Once the location has been planned properly, trail and facility design becomes important. Ensuring proper slope alignment and water bars are essential elements of trail design that reduce erosion and sediment delivery into streams. (Marion, 2006; Schlichte, 1998). Trail hardening measures, such as using geotextiles and/or capping the surface, can also be effective in reducing environmental impacts where there are high amounts of use, or high impact types of recreational uses. (Meyer, 2002; Schlichte, 1998). Placing requirements on group size for a campground, creating physical barriers, and maintaining campgrounds to a level at which they appear attractive are all means to help concentrate camping in a given area and minimize the trampling of vegetation. (Marion and Farrel, 2002). While there is an initial investment to the design and construction of a trail or campground, this proactive approach may be necessary to reduce environmental degradation.

Maintenance

Even properly located and designed facilities and trails need to be adequately maintained in order to minimize environmental impacts. As the amount of use increases, or the type of use becomes more intense, the need for additional maintenance also increases. (Schlichte, 1998). For instance, drainage features like water bars are only useful when properly maintained. (Meyer, 2002, Schlichte 1998). A popular trail or facility which is poorly maintained will eventually have its drainage features worn away over time. (Schlichte, 1998). Heavy use can also make a trail start to cup. Cupping occurs when the trail begins to become a narrow ditch in which water cannot flow off the side of the trail, but rather is channeled down the middle. By maintaining facilities and trails in relation to the intensity of use, the environmental benefits from the proper design and construction can continued to be realized. (Meyer, 2002, Schlichte 1998).

Enforcement

Where undesignated recreational use needs to be stopped because of causing environmental degradation, an enforcement action may be needed to close the area. However, closures are seldom effective in stopping use, unless that use is directed to an area better suited for the environmental impacts. (Lueng and Marion, 2002). In order to successfully implement a closure, a capable and determined enforcement program is needed. (Leung and Marion, 2002; Meyer, 2002). Recovery rates for a natural resource will vary depending on the landscape and the type of environmental impact (e.g., soil loss usually requires longer recovery). (Liddle, 1997). Seasonal closures are an effective means of avoiding substantial environmental impacts to trails and campgrounds during the seasons they are most susceptible to degradation, such as during the winter. (Meyer, 2002). However, seasonal closures to allow trails to recover are seldom effective, as recovery rates on a given landscape are almost always slower than their deterioration rates. (Cole and Monz, 2004).

Relocation

When a trail or campground is located on a landscape that is highly susceptible to environmental impacts, relocation may be appropriate. (Marion, 2006; Meyer, 2002). Trail rerouting can be an effective means of reducing environmental impacts when there is an opportunity to place a trail in a location where soils and terrain are better suited to withstand environmental impacts. (Marion, 2006; Meyer, 2002). Relocating a trail or campground requires the same type of planning and design that would occur with a new trail or campground, and as a result, a sizeable investment is needed to implement such relocation. While costly, relocating a trail or campground is usually much less expensive than mitigating the environmental impact through trail hardening methods or constant restoration of an area.

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